

## Case Review

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# Primary sternal tuberculosis: a case report and review of the literature

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**Introduction:** Primary sternal osteomyelitis caused by *Mycobacterium tuberculosis* is a rare manifestation of extrapulmonary tuberculosis.

**Case presentation:** We present a case of isolated sternal tuberculosis and review the demographic, clinical, diagnostic and therapeutic features of 32 published cases found in a systematic review of the literature. Patients with primary sternal osteomyelitis due to *M. tuberculosis* are often young and have no co-morbidity. Diagnosis is frequently delayed. Common symptoms and signs are local swelling and a discharging sinus tract. Patients frequently have at least one systemic symptom, including fever, weight loss and night sweats. Our case and half of those found in the literature review were successfully treated with antituberculous drugs alone.

**Conclusion:** Treatment concepts for primary sternal tuberculosis are not established and are often derived from those of osteoarticular tuberculosis. These data point towards an interdisciplinary concept without surgery.

**Keywords:** sternal osteomyelitis; TB medication; tuberculosis.

## Background

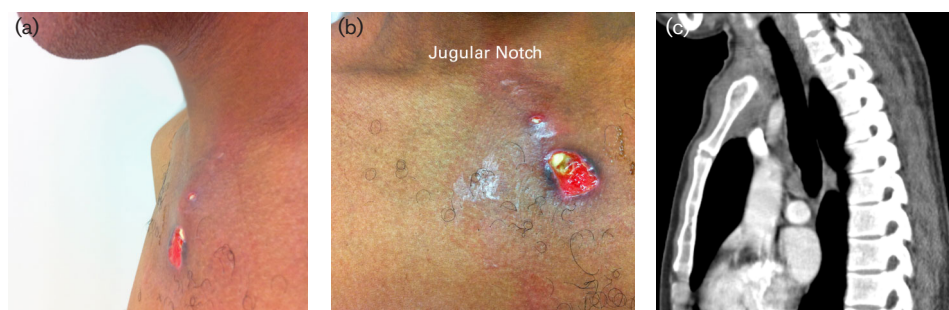
Tuberculosis (TB) can disseminate to almost every organ after a primary infection or reactivation of latent foci. Osteoarticular TB accounts for approximately 10 % of extrapulmonary TB and up to 2 % of all TB cases in the USA (Peto *et al.*, 2009; CDC, 2013). While the spine is the most common site of osteoarticular TB, osteomyelitis of the sternum is rare. In clinical series, the reported incidence is approximately 1 % of all bone and joint TB cases (Enarson *et al.*, 1979; Davies *et al.*, 1984; Ali *et al.*, 2008). The majority of reported sternal TB cases occur secondary to sternotomy. Because TB of the sternum is uncommon, the diagnosis is often delayed, and treatment concepts are not standardized. We present a case of primary sternal TB and review the demographic, clinical, diagnostic and therapeutic features of 32 cases found in a systematic review of the literature.

## Case report

A 35-year-old man from Ethiopia presented with a fluctuant mass over the upper sternum. It gradually developed over 2 months prior to referral. The lesion was excised, a swab sample taken and a course of oral antibiotics given. No bacterial growth was detected, and the antimicrobial treatment had no beneficial effect.

Because the lesion continued to grow, he was referred to our centre. His previous medical history was unremarkable. On clinical examination, two pre-sternal fistulous lesions were detected (Fig. 1a, b). White blood cell counts, C-reactive protein levels and chest X-rays were unremarkable. The result of a human immunodeficiency virus antibody test was negative. A computed tomography (CT) scan of the thorax revealed a heterogeneous soft-tissue mass from the posterior of the manubrium sterni up to the skin surface (Fig. 1c). In the CT scan, no pathological findings in the pulmonary parenchyma, pleura and lymph nodes were detected. Deep biopsy samples from the lesions were obtained. The histopathological result was consistent with caseous necrosis. The results of an auramine stain for acid-fast bacilli were negative, but PCR was positive for *Mycobacterium tuberculosis* complex DNA. Thus, a diagnosis of sternal TB was made. Because of this diagnosis, the previous CT scan was reviewed again. Even in retrospect, only a single non-specifically enlarged para-aortic lymph node was found (diameter 18 mm). Antituberculous therapy with isoniazid, rifampicin, ethambutol and pyrazinamide was initiated. *M. tuberculosis* grew in cultures 5 weeks later and was susceptible to all tested antituberculous drugs. After 2 months of treatment, the lesions had healed completely. The antituberculous therapy was reduced to two compounds (rifampin and isoniazid) and continued for 7 months. At the 15-month follow-up visit, the patient was in good health.

Abbreviations: CT, computed tomography; TB, tuberculosis.



**Fig. 1.** (a) Non-erythematous swelling over the upper manubrium. (b) Ulcer with discharging sinus over the upper manubrium and fistulous lesion in the region of the jugular notch. (c) Heterogeneous soft-tissue mass posterior to the manubrium sterni extending up to the skin surface.

## Methods

The PubMed database was searched for primary sternal TB cases by using the keywords 'sternum' AND 'tuberculosis' and 'tubercular osteomyelitis' AND 'sternum'. The literature search included cases that were published from 1 January 1966 to 1 March 2013. Patients younger than 18 years of age and cases reported in a language other than English were excluded. A total of 70 articles were retrieved by the search. References cited in each of these articles were also reviewed for any additional eligible articles. Nine further cases were thereby identified. In total, 36 of the 79 articles were excluded after reviewing only the title or the abstract. Sixteen articles were excluded after reviewing the full text or because of insufficient data. Finally, a total of 27 articles reporting 32 cases were included in our review (Table 1).

## Review and Discussion

Although primary sternal TB is rare, the clinical presentation in this case is even more uncommon. No body site was indicative for TB, neither the proximate lymph nodes nor the lung. The persistent ulcers and the patient's origin were the key to the diagnosis. The demographic characteristics in our case (i.e. an otherwise healthy young man) were similar to those found in the literature. Primary sternal TB was more common in men (76 %) and occurred at a relatively young age (mean 40.3 years, median 37.0, range 18–74). All patients except one were either residents of or had immigrated from countries endemic for TB. There were only seven reports that described possible predisposing conditions for TB reactivation, including diabetes mellitus in four patients. This finding is different than in cases with sternal TB after sternotomy, in which co-morbidities were more frequently described (Wang *et al.*, 2007).

The mean duration of symptoms prior to diagnosis was 6.3 months (median 3, range 1–72). Swelling (87.5 %, 28 patients), pain (43.8 %, 14 patients) and a discharging sinus tract (34.4 %, 11 patients) were the most common

symptoms. Most patients also had at least one systemic symptom: 18 of 32 patients (56.3 %) had fever, 16 (50 %) had weight loss and anorexia, and seven (21.9 %) had night sweats. In comparison with those reported in sternal TB after sternotomy (Wang *et al.*, 2007), systemic symptoms in primary sternal TB were described more frequently.

The erythrocyte sedimentation rate was reported in 27 of 32 patients and was always elevated (mean 70 mm h<sup>-1</sup>, median 60, range 25–140). However, in our view, this laboratory parameter is not helpful in clinical practice. In our patient, the sternum was the only site of TB manifestation. Among the 32 reviewed patients, 13 (40.6 %) had evidence of TB at additional body sites, with lymph node involvement (seven cases) being most frequently reported. Five patients had musculoskeletal involvement at multiple sites. Three patients had pulmonary TB; formally, these three sternal TB cases are not considered as extrapulmonary TB (WHO, 2009). These data indicated that the pathogenesis was seeding via the haematogenous or lymphogenous route in most cases. The pathogenesis in our case is unclear. Because no other site of infection was found, we postulate a haematogenous seeding. Another possibility could be an infection of retrosternal lymph nodes that erode into the sternum over time. However, even in retrospect, we cannot draw any conclusion from the CT scan.

There are no specific radiological features that are pathognomonic for osteoarticular TB (Watts and Lifeso, 1996). In our review, most of the patients had, in addition to the chest X-ray, further imaging studies [CT scan (23 of 32 patients), magnetic resonance imaging (six of 32 patients) or bone scan (seven of 32 patients)]. Common findings included bone erosion or destruction, signs of sequestra and abscesses. The magnetic resonance imaging was helpful for determination of the delineation of the adjacent soft tissue.

In our case, the results of an auramine stain of the specimen were negative. This result was reported in 20 of the reviewed cases and was positive in 13 (65 %) of them.

**Table 1.** Details of 33 cases with primary sternal TB

Study	Age (years)	Gender	Possible predisposing condition	Symptoms and clinical findings at sternum	Systemic symptoms	Duration of symptoms (months)	ESR (mm h <sup>-1</sup> )	Other foci	Surgery*	Anti-TB drugs†	Duration of therapy (months)	Outcome	Follow-up (months)
Singh <i>et al.</i> (2011)	20	F	None	Pain, swelling	None	12	40	Coccyx; left gluteus	No	R, I, P, E	6	Cured	36
Singal <i>et al.</i> (2011)	65	M	None	Pain, swelling, discharge	None	11	75	None	No	R, I, P, E	NR	Cured	3
Barbetakis <i>et al.</i> (2011)	48	M	NR	Swelling	Fever, anorexia	6	60	None	Resected	R, I, P, E	NR	Cured	6
Boorugu <i>et al.</i> (2009)	28	M	NR	Swelling	Fever, weight loss	3	140	Lymph nodes	No	R, I, P, E	12 (10 R, I)	NR	Lost to follow-up
Khatra <i>et al.</i> (2009)	37	M	NR	Swelling	Fever, weight loss	3	60	None	No	4 drugs, NS	NR	Cured	NR
	55	M	NR	Swelling, discharge	Weight loss	1	50	None	No	4 drugs, NS	NR	Cured	NR
Gupta <i>et al.</i> (2009)	20	M	NR	Swelling, discharge	Fever, weight loss	6	46	Lymph nodes	No	4 drugs, NS	NR	Cured	NR
Bhatia <i>et al.</i> (2009)	21	F	None	Swelling	NR	3	NR	None	Resected	NS	NR	Cured	NR
	70	M	None	Swelling, erythema	NR	4	NR	None	Resected	NS	NR	Cured	NR
Safudheen <i>et al.</i> (2010)	42	M	Diabetes	Pain, swelling	Weight loss, night sweats	2	80	None	No	R, I, P, E	6 (2 R, I)	Cured	≥ 6
Sendi <i>et al.</i> (2008)	19	M	Trauma	Swelling	Weight loss, night sweats	5	NR	Lung; calcaneus	No	NS	12	Cured	24
Mohammadi & Howell (2009)	32	M	NR	Swelling, erythema, discharge	Fever, night sweats	3	NR	Lymph nodes	No	R, I, P, E	NR	Cured	NR
Bandyopadhyay <i>et al.</i> (2005)	55	F	None	Swelling	Fever, weight loss	3	110	Thoracic vertebra (D4/5,8/9), including prevertebral and epidural tissue	No	NS	NR	Cured	NR

Table 1. Continued.

Ford <i>et al.</i> (2005)	27	F	NR	Swelling	NR	4	NR	None	Debrided	R, I, P, E	9 (3 R, I)	Cured	3
McLellan <i>et al.</i> (2000)	35	M	NR	Pain, swelling, erythema	Fever	3	67	None	Debrided	R, I, P, E	12 (9 R, I)	Cured	3
Mulloy (1995)	59	F	NR	Swelling	None	12 (cough); 3 (mass)	50	Thoracic vertebra (D6), rib	Debrided	R, I, P, E	9	Cured	NR
Mineo & Biancari (1995)	28	M	NR	Pain, swelling	Fever	3	78	Lymph node	Explored	NR	NR	NR	NR
Watts <i>et al.</i> (1987)	40	M	NR	Pain, swelling	Weight loss, fever	3	87	None	Explored	R, I, P, E	NR	Cured	NR
	49	M	Diabetes	Pain, swelling	Fever, weight loss, night sweats	30 (pain); 3 (mass)	64	Rib, paraspinal abscess at the thoraco-lumbar junction	No	4 drugs, NS	NR	Cured	NR
de Carli <i>et al.</i> (2009)	74	M	Alcoholism, chronic heart, renal failure	Pain, swelling, erythema, discharge	Fever, weight loss, night sweats	12	48	None	Explored	R, I, P	NR	Cured	NR
Vasa <i>et al.</i> (2009)	55	M	NR	Pain, swelling, erythema	Night sweats	30 (pain); 2 (mass)	88	Lymph nodes	No	R, I, P, E	>6 (NS, R, I)	Cured	6
Bajracharya <i>et al.</i> (2006)	35	M	NR	Erythema, discharge	Fever, anorexia	3	48	None	No	R, I, P, E	12 (9 R, I)	Cured	NR
	57	M	NR	Erythema, discharge	Fever, anorexia	5.5	60	None	No	R, I, P, E	12 (9 R, I)	Cured	NR
Jain <i>et al.</i> (2007)	18	M	None	Pain, discharge	Fever, weight loss, night sweats	2	50	None	No	R, I, P, E	17 (3 R, I, E, 10 R, I)	Cured	29
Dhingra <i>et al.</i> (2005)	31	M	None	Pain, swelling	Fever, weight loss	2	31	Lymph nodes	No	R, I, P, E	7 (4 R, I, E)	Cured	NR
Prakash & Hira (2000)	40	F	Diabetes	Swelling	Fever, weight loss	1.5	120	Lung	Debrided	R, I, P, E	9 (7 R, I)	Cured	24
Subba Rao <i>et al.</i> (1982)	50	M	NR	Pain, discharge	NR	NR	60	None	Resected	NS	NR	Cured	6

Table 1. Continued.

Ashour & Pandya (1990)	24	M	None	Swelling	NR	NR	25	Lymph nodes	Resected	4 drugs, NS	NR	Cured	12
	55	F	History of pulmonary TB	Swelling	Fever	2	130	Lung	Debrided	NS	NR	Died	NR
Rasaretnam <i>et al.</i> (1997)	31	M	NR	Pain, swelling, erythema	Anorexia, weight loss	3	121	None	Debrided	R, I, P, E	6 (2 R, I, E)	Cured	12
Vyranathan and Nadarajah (1981)	32	F	INA	Discharge	INA	72	60	None	NR	I, PAS, S	INA	Cured	INA
Gafosse <i>et al.</i> (1995)	42	M	Diabetes	Pain, swelling	Fever, weight loss	6	50	None	Explored	R, I, P, E	NR	Cured	NR
This case	36	M	None	Swelling, discharge	None	2		None	No	R, I, P, E	9 (7 R, I)	Cured	15

M, male; F, female; NR, Not reported; INA, Information not available; NS, Not specified; ESR, erythrocyte sedimentation rate; R, rifampicin; I, isoniazid; P, pyrazinamide; E, ethambutol; PAS, para-aminosalicylic acid; S, streptomycin. \*'Resected' included partial or total resection of sternal bone; 'explored' included macroscopic inspection of the sternal infection with or without biopsy sampling. †If not specified otherwise, compounds administered as initial therapy.

In 32 patients, 21 culture results were reported, of which 19 were positive for *M. tuberculosis* (90.5 %). Khan *et al.* (2007) reported a lower rate of positive culture results in their series (43 %). PCR for *M. tuberculosis* complex is a rapid and sensitive test for the diagnosis of TB, especially in those with equivocal histopathological findings. The test has been reported as a useful diagnostic tool in bone TB, with a sensitivity of 85 % and a specificity of 80 % (Jambhekar *et al.*, 2006). In our review, PCR was reported in 12 of 32 patients (37.5 %) and confirmed the diagnosis in all of them.

There is no consensus regarding the optimal treatment modality of sternal TB. The role of surgery in the management of sternal TB after sternotomy is more established. In a review by Wang *et al.* (2007), all but one patient underwent surgical debridement. Our case was managed without surgery, as were 50 % of the patients found in the review. Some authors suggest that medical treatment alone is effective and that surgery should be limited to cases with large sequestra or to refractory cases (i.e. no signs of healing of the lesion after 3 months of therapy) (Hsu *et al.*, 1995; McLellan *et al.*, 2000). Other experts postulate that extensive debridement is essential to prevent recurrence (Kim *et al.*, 2008). In primary sternal TB, Khan *et al.* (2007) reported excellent results with conservative management alone in 12 of 14 patients. Similarly, Ali *et al.* (2008) showed in their case series that all 19 patients with isolated sternal TB responded well to a 12-month course of antituberculous treatment. Based on our experience of this and other extrapulmonary cases, and the results from the literature review, we are in favour of a conservative approach, unless there are signs of a large abscess or sequestra.

Treatment duration in our patient was 9 months. Treatment among our reviewed cases ranged from 6 to 17 months. This wide range reflects the controversial aspects in the treatment duration of osteoarticular manifestations. The World Health Organization (WHO, 2009) and the British Thoracic Society (1998) recommend the same treatment duration for both extrapulmonary and pulmonary TB. Other institutions recommend 9 months for osteoarticular TB because of the difficulties in assessing the treatment response (Blumberg *et al.*, 2003). In our patient, the treatment response could be observed by rapid wound healing. Thus, in retrospect, a 6-month treatment duration would probably have been sufficient. Two studies of the Medical Research Council Working Party on Tuberculosis of the Spine demonstrated the validity of the 6-month regimen (1986, 1999). Data regarding treatment length for sternum osteomyelitis are lacking.

## Conclusion

In conclusion, isolated primary sternal osteomyelitis due to *M. tuberculosis* is rare. Patients are often relatively young and have no co-morbidity. The diagnosis is frequently delayed. Common symptoms and signs are local swelling, pain and a discharging sinus tract. Many patients described



in the literature have systemic symptoms, including fever, weight loss and night sweats. While surgery is often performed in patients with secondary sternal TB, this is not the case for patients with primary sternal TB. Our patient and half of the cases found in the literature review were successfully treated with antituberculous drugs alone.

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## References

- Ali, W. M., Beg, M. H., Rashid, M., Zafar, U. & Abbas, S. N. (2008). An experience with a rare diagnosis of isolated tuberculosis of sternum at JNMC Hospital, Aligarh, India. *Saudi Med J* 29, 580–583.
- Ashour, M. & Pandya, L. (1990). Tuberculosis of the sternum. *Ann Saudi Med* 10, 57–59.
- Bajracharya, S., Singh, G. & Singh, M. (2006). Primary tubercular osteomyelitis of the sternum: report of two cases. *Internet J Third World Med* 5.
- Bandyopadhyay, S. K., Moulick, A., Ghosal, J. & Dutta, A. (2005). Presternal cold abscess. *J Assoc Physicians India* 53, 866.
- Barbetakis, N., Asteriou, C., Kleontas, A. & Karvelas, C. (2011). Primary sternal tuberculosis mimicking anterior chest wall tumor: case report. *Tuberk Toraks* 59, 164–167.
- Bhatia, V. Y., Aggarwal, V., Sharma, U. & Gupta, A. (2009). Primary tuberculous sternal osteomyelitis: a clinical rarity. *Asian Cardiovasc Thorac Ann* 17, 310–312.
- Blumberg, H. M., Burman, W. J., Chaisson, R. E., Daley, C. L., Etkind, S. C., Friedman, L. N., Fujiwara, P., Grzemska, M., Hopewell, P. C. & other authors (2003). American Thoracic Society/Centers for Disease Control and Prevention/Infectious Diseases Society of America: treatment of tuberculosis. *Am J Respir Crit Care Med* 167, 603–662.
- Boorugu, H. K., Chrispal, A. & Thomas, E. M. (2009). Sternal tuberculous osteomyelitis presenting as a pulsatile swelling. *Indian J Tuberc* 56, 154–156.
- CDC (2013). *Reported Tuberculosis in the United States, 2012*. Atlanta, GA: US Department of Health and Human Services.
- Davies, P. D., Humphries, M. J., Byfield, S. P., Nunn, A. J., Darbyshire, J. H., Citron, K. M. & Fox, W. (1984). Bone and joint tuberculosis. A survey of notifications in England and Wales. *J Bone Joint Surg Br* 66, 326–330.
- de Carli, D. M., Severo, M. D., Haygert, C. J., Guollo, M., Omaili, A., Pedro, V. D., Silva, E. P. & Rodrigues, A. T. (2009). Sternal osteomyelitis caused by infection with *Mycobacterium tuberculosis*. *J Bras Pneumol* 35, 709–712.
- Dhingra, V. K., Rajpal, S., Gupta, U. A., Aggarwal, J. K., Mandal, A. K. & Chowdhury, V. (2005). A young man with midline swelling over the front of chest. *Indian J Tuberc* 52, 93–98.
- Enarson, D. A., Fujii, M., Nakielnia, E. M. & Grzybowski, S. (1979). Bone and joint tuberculosis: a continuing problem. *Can Med Assoc J* 120, 139–145.
- Ford, S. J., Rathinam, S., King, J. E. & Vaughan, R. (2005). Tuberculous osteomyelitis of the sternum: successful management with debridement and vacuum assisted closure. *Eur J Cardiothorac Surg* 28, 645–647.
- Gatfosse, M., Zellner, P. & Barjonet, G. (1995). Tuberculosis of the sternum. Report of a case. *Rev Rhum Engl Ed* 62, 152–153.
- Gupta, R., Gupta, A., Gupta, K. B. & Sood, S. (2009). Sternal tuberculosis and gynecomastia. *J Postgrad Med* 55, 276–277.
- Hsu, H. S., Wang, L. S., Wu, Y. C., Fahn, H. J. & Huang, M. H. (1995). Management of primary chest wall tuberculosis. *Scand J Thorac Cardiovasc Surg* 29, 119–123.
- Jain, V. K., Singh, Y., Shukla, A. & Mittal, D. (2007). Tuberculous osteomyelitis of sternum: A case report. *J Clin Diagn Res* 1, 163–167.
- Jambhekar, N. A., Kulkarni, S. P., Madur, B. P., Agarwal, S. & Rajan, M. G. (2006). Application of the polymerase chain reaction on formalin-fixed, paraffin-embedded tissue in the recognition of tuberculous osteomyelitis. *J Bone Joint Surg Br* 88, 1097–1101.
- Joint Tuberculosis Committee of the British Thoracic Society (1998). Chemotherapy and management of tuberculosis in the United Kingdom: recommendations. *Thorax* 53, 536–548.
- Khaira, A., Khaira, D. D., Gupta, A., Bhowmik, D., Kalra, O. P. & Tiwari, S. C. (2009). Tuberculosis of sternum: three cases with different presentations. *J Assoc Physicians India* 57, 595–596.
- Khan, S. A., Varshney, M. K., Hasan, A. S., Kumar, A. & Tripathi, V. (2007). Tuberculosis of the sternum: a clinical study. *J Bone Joint Surg Br* 89, 817–820.
- Kim, Y. T., Han, K. N., Kang, C. H., Sung, S. W. & Kim, J. H. (2008). Complete resection is mandatory for tubercular cold abscess of the chest wall. *Ann Thorac Surg* 85, 273–277.
- McLellan, D. G., Philips, K. B., Corbett, C. E. & Bronze, M. S. (2000). Sternal osteomyelitis caused by *Mycobacterium tuberculosis*: case report and review of the literature. *Am J Med Sci* 319, 250–254.
- Medical Research Council Working Party on Tuberculosis of the Spine (1986). A controlled trial of six-month and nine-month regimens of chemotherapy in patients undergoing radical surgery for tuberculosis of the spine in Hong Kong. Tenth report of the Medical Research Council Working Party on Tuberculosis of the Spine. *Tubercle* 67, 243–259.
- Medical Research Council Working Party on Tuberculosis of the Spine (1999). Five-year assessment of controlled trials of short-course chemotherapy regimens of 6, 9 or 18 months' duration for spinal tuberculosis in patients ambulatory from the start or undergoing radical surgery. Fourteenth report of the Medical Research Council Working Party on Tuberculosis of the Spine. *Int Orthop* 23, 73–81.
- Mineo, T. C. & Biancari, F. (1995). Sternal mass and fever. *Postgrad Med J* 71, 569–571.
- Mohammadi, A. & Howell, J. M. (2009). Sternal tuberculosis. *J Emerg Med* 36, 342–344.
- Mulloy, E. M. (1995). Tuberculosis of the sternum presenting as metastatic disease. *Thorax* 50, 1223–1224.
- Peto, H. M., Pratt, R. H., Harrington, T. A., Lobue, P. A. & Armstrong, L. R. (2009). Epidemiology of extrapulmonary tuberculosis in the United States, 1993–2006. *Clin Infect Dis* 49, 1350–1357.
- Prakash, A. & Hira, H. S. (2000). Tuberculous osteomyelitis of sternum in a diabetic. *Indian Journal of Tuberculosis* 48, 35–36.
- Rasaretnam, R., Wijesekera, C. & Wickramasekera, D. (1997). Sternal osteomyelitis. *Ceylon Med J* 42, 198–199.
- Saifudheen, K., Anoop, T. M., Mini, P. N., Ramachandran, M., Jabbar, P. K. & Jayaprakash, R. (2010). Primary tubercular osteomyelitis of the sternum. *Int J Infect Dis* 14, e164–e166.
- Sendi, P., Friedl, A., Graber, P. & Zimmerli, W. (2008). Reactivation of dormant microorganisms following a trauma. Pneumonia, sternal abscess and calcaneus osteomyelitis due to *Mycobacterium tuberculosis*. *Neth J Med* 66, 363–364.
- Singal, R., Singh, P., Mittal, A., Gupta, S., Singla, S. & Kenwar, D. B. (2011). Primary sternal tuberculous ulcer with dissemination to the bone marrow: a clinical rarity. *Ann Saudi Med* 31, 542–545.

**Singh, S., Nagaraj, C., Khare, G. N. & Kumaraswamy, V. (2011).** Multicentric tuberculosis at two rare sites in an immunocompetent adult. *J Orthop Traumatol* **12**, 223–225.

**Subba Rao, K. S. V. K., Gupta, B. K. & Ramakrishnan, K. (1982).** Tuberculous osteomyelitis of the sternum. *Indian J Tuberc* **29**, 244–246.

**Vasa, M., Ohikhuare, C. & Brickner, L. (2009).** Primary sternal tuberculosis osteomyelitis: a case report and discussion. *Can J Infect Dis Med Microbiol* **20**, e181–e184.

**Vyrvanathan, S. & Nadarajah, N. (1981).** Tuberculosis of the skin over the sternum. *Jaffna Med J* **16**, 23–28.

**Wang, T. K., Wong, C. F., Au, W. K., Cheng, V. C. & Wong, S. S. (2007).** *Mycobacterium tuberculosis* sternal wound infection after open heart surgery: a case report and review of the literature. *Diagn Microbiol Infect Dis* **58**, 245–249.

**Watts, H. G. & Lifeso, R. M. (1996).** Tuberculosis of bones and joints. *J Bone Joint Surg Am* **78**, 288–298.

**Watts, R. A., Paice, E. W. & White, A. G. (1987).** Spontaneous fracture of the sternum and sternal tuberculosis. *Thorax* **42**, 984–985.

**WHO (2009).** Treatment of tuberculosis: guidelines, 4th edn. [http://whqlibdoc.who.int/publications/2010/9789241547833\\_eng.pdf](http://whqlibdoc.who.int/publications/2010/9789241547833_eng.pdf). Geneva: World Health Organization.